A GRAPHIC METHOD OF REPRESENTING THE CHEMICAL RELATIONS OF A PETROGRAPHIC PROVINCE

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During recent years questions concerning the chemical composition of rock magmas, and the relation of these to one another, have been made the subject of extended investigation on the part of petrographers. A great number of rock types, and of many variations presented by these types, have been analyzed with great accuracy, so that now the material available for such studies has enormously increased.

As it is a matter of difficulty in comparing a long series of analyses to grasp clearly their various points of resemblance or difference, and to recognize the relationships, often more or less obscure, presented by the different types, investigators have from time to time sought to express the results of these analyses graphically so that by a comparative study of forms rather than figures the relationships in question might be brought out more clearly and presented in a more striking manner.

It is unnecessary here to consider in detail the various methods of graphic representation suggested by different workers. A review of the various methods proposed will be found in a paper by Iddings which appeared some years since.[1] Some of these methods, as for instance that of Reyer, show the relative proportions of the several chemical constituents present in the rock by means of a figure in which areas representing the various constituents are variously shaded or distinguished by different conventions. Others, such as that employed by Harker, indicate the relative proportions of the constituents by means of a curve on a plain surface. In a third class, such as those used by Brögger, the composition of the rock is represented by a geometrical outline whose shape would vary as the composition of the rock changed.

[1] J. P. Iddings, *Prof. Paper 18*, *U.S. Geol. Survey*, 1903.

Each of these methods of graphic representation has its peculiar merits, and each has also its disadvantages, which become manifest when it is desired by means of them to compare a long series of analyses, as for instance those representing a whole petrographic province.

In connection with some studies on the character and relations of the very striking series of alkaline rocks composing the petrographical province of the Monteregian Hills, which are now being carried on at McGill University, the attempt has been made to secure a more satisfactory expression of the chemical relations of the rocks of this province by employing a graphic representation in three dimensions. It is desired in the present brief paper to give an outline of the method employed and the result obtained.

Each of the analyses, 36 in number, was first plotted in the form of a curve which showed the actual and relative proportions of each of the chief constituents present in the rock. These are: silica, titanic acid, alumina, ferric oxide, ferrous oxide, lime, magnesia, potash, soda, water, carbonic dioxide.

The manganous oxide present was placed with the ferrous oxide and any small percentages of baryta or strontia with the lime. For purposes of simplicity other constituents, such as chlorine and sulphuric acid, which are occasionally present in small amount, were neglected, although of course it would be possible to represent them in the curve were it considered desirable to do so.

This curve was constructed by drawing a horizontal line, and marking off on it a series of points at equal distances from one another. At each of these points an ordinate was erected. On the first of the ordinates was plotted the molecular proportion of silica present in the rock. On the next ordinate the amount of titanic acid was similarly plotted, and on each of the others in succession the molecular proportions of the other constituents of the rock in the order enumerated above was shown. The points so obtained were then connected, and a curve thus constructed which shows in graphic form the chemical composition of the rock. In Fig. 1 there is seen the curve thus obtained for a camptonite occurring in the form of a dyke cutting the Trenton limestone at

the reservoir extension on the slope of Mt. Royal. A curve was obtained in a similar manner for each of the 36 analyses of the series.

These curves were then combined so as to give a value to the third dimension. For this purpose each curve was traced on a

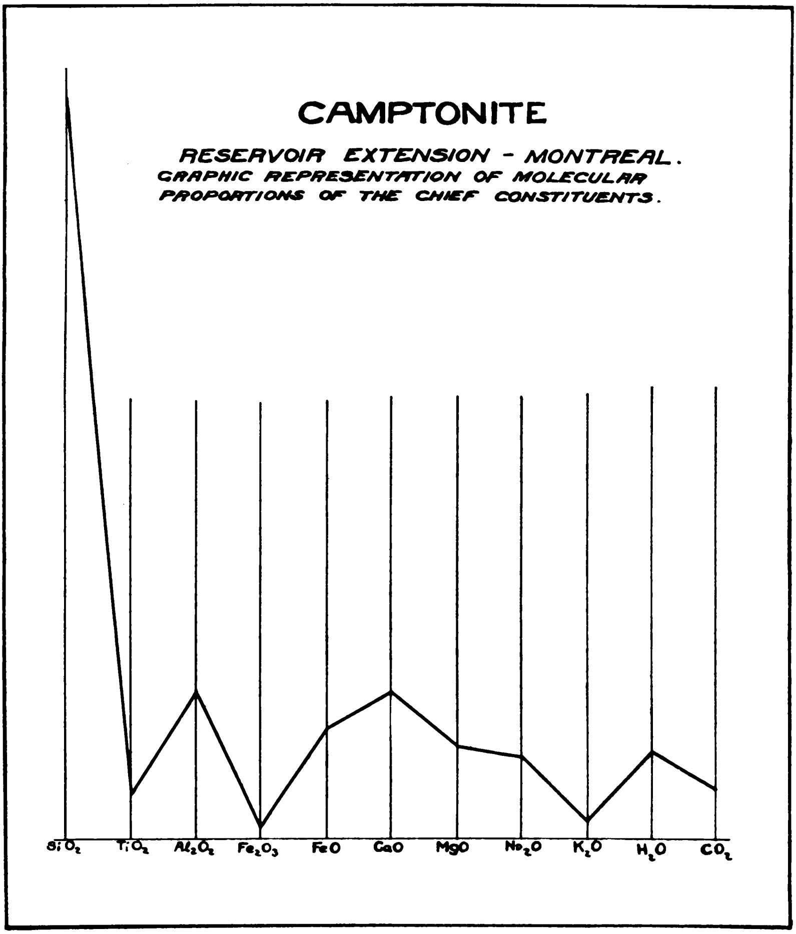

FIG. 1

thin rectangular sheet of metal, which was then cut so that its upper edge presented the outline of the curve, while the other three edges retained their rectilinear character. The form of the sheet representing the analysis of the camptonite has thus exactly the form of the diagram shown in Fig. 1.

These sheets of metal were then arranged in an upright position in a stout wooden frame, one in front of the other, at a distance of one inch apart. That of the rock having the highest content of silica was placed at one end of the series, while the others were arranged in the order of decreasing silica content, the most basic rock occupying the other end of the series. The spaces between the plates were then filled in with plaster of paris, the plaster

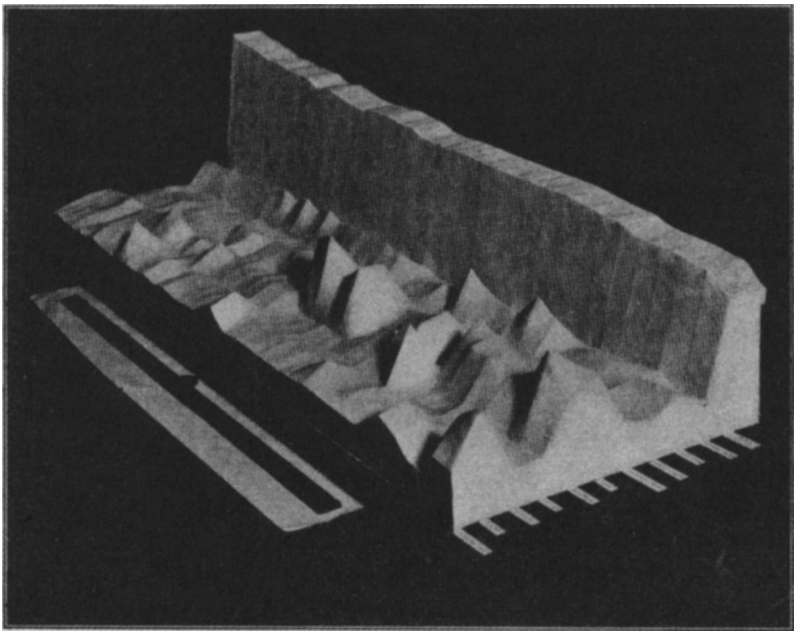

Fig. 2.—Model showing the chemical composition of the various rock types of the petrographical province of the Monteregian Hills.

between the successive sheets being smoothed down, so that the model thus completed presented a warped surface, passing transversely across which can be distinctly seen the traces of the curves representing the composition of the constituent rocks of the series.

The model thus obtained is shown in Fig. 2. A margin about one inch in width was left on the silica side of the model, to give space opposite the curve of each analysis to attach a small label having printed on it the name of the rock and the locality from

which it was obtained. In a similar manner the base on which the model rests is made to project a short distance at one end, so that another set of labels showing the chemical constituents represented in the analyses may be placed upon it. In this way, looking down the length of the model the character of the variation in the content of any chemical constituent in the series of rocks composing this petrographical province can be seen at a glance.

The predominance of any constituent, or group of constituents, in a certain part of the series is shown by a hill rising from the surface of the model, the shape of the hill varying according to minor variations in chemical composition of the rocks of this portion of the series. Depressions, on the other hand, indicate low percentages of a constituent, or group of constituents, in certain portions of the series.

The model shown in Fig. 2, representing the chemical relations of the rocks constituting the Monteregian Hills, combines the results of 36 analyses, the rocks ranging in composition from the acid nordmarkite of Mt. Shefford, containing 65.43 per cent of silica, at one end of the series, to the basic alnoite of Point St. Charles, near Montreal, holding 29.24 per cent of silica, at the other end. The intervening portion of the model shows the chemical composition and the mutual relations of the magmas of intervening acidity represented by the pulaskites, nepheline syenites, essexites, rouvellites, tinguaites, camptonites, montrealites, tawites, rougemontites, yamaskites, monchiquites, etc., of this petrographical province.

The model is 36 inches long, 12 inches wide, and 8½ inches high at the highest part. It appears to present in a clear and rather striking manner the chemical relations of the alkaline magmas of this peculiar petrographical province, and similar models might be readily constructed which would set forth the characteristic relations of other provinces.